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1st BIMONTHLY REPORT
STUDIES OF THE OUTSTANDING DEFICIENCIES
OF THE E41 ALARM

FOR U. S. ARMY CBR AGENCY
EDGEWOOD ARSENAL, MARYLAND
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LOW AIRFLOW SENSING DEVICE

The first work performed under the task of sensing low airflow levels was toward developing a method utilizing pump motor current changes. This approach to the problem relies on the fact that when airflow is restrained, the motor current will rise and can be detected. The obvious problem with this method is that the wide variation in battery supply voltage will also cause considerable changes in motor current. Thus, at high battery voltage high current would cause a malfunction signal. Therefore, the sensing device must electronically compensate for this factor by providing a sliding reference as a function of battery voltage and resulting motor current. Consequently, data was collected on the E41R2 Alarm Serial No. 48 pump-motor characteristics. The attached graph shows the changes in motor current as a function of battery voltage for various restrictions of airflow. Curve 1 represents data taken during normal operation of the device. Each higher numbered curve represents data taken with a greater fixed restriction on the output airflow. It will be observed that the operating current curve is raised as the restriction or load is increased up to the extreme point of very low airflow when the pump flutter valves no longer operate properly, unloading the pump. This data indicated the compensation needed in the electronic design.

The required transistor circuit was designed and tested in a feasibility test breadboard. The circuit operates satisfactorily, operating a malfunction light whenever airflow drops to a preselected level of airflow in the range from 0.6 to 0.8 liters per minute. That is, if we select 0.6 liters/min. as the set point, the device will signal malfunction whenever the airflow is restricted to this level despite

changes in the specified battery voltage.

At present parts are on order for an operational circuit utilizing the components and miniature relays which are capable of operation at the required environmental conditions. It should be noted that further work will be necessary on this model to compensate for temperature effects on the motor current. The motor-pump combination exhibits a drop in operating current at any given voltage as the temperature is increased. This could make the sensor incapable of detecting interference with airflow. Consequently, the circuit will have temperature compensation for this effect.

It should be pointed out that one of the requirements placed on the pump-motor combination will require the pump not "unload" due to improper valve action. It is therefore felt necessary that a number of pump-motor combinations from various manufacturers now considered to be purchase sources be tested.

STANDARDIZATION CIRCUIT

A restandardization circuit, similar to the one developed by CRDL, has been breadboarded.

The circuit differs from that of CRDL by the tube type; i.e., CK5686 were used instead of the VX55 because of considerable difference in cost.

In addition, a system to "read out" the action of the photocell in conjunction with the restandardization circuit, has been developed. It makes use of a Schmidt trigger coupled to the output of the tubes by means of three transistors.

At this time the feasibility of putting the filaments of the tubes in series with the exciter lamp is being studied. This arrangement is highly desirable since it would introduce practically no additional drain on the battery.

While these items are now being evaluated, we are also attempting to achieve an improved method of restandardization whereby the active elements therein would be of the solid state type. Our thinking about this problem may be categorized as follows:

1. Use of a transistorized differential amplifier circuit (as the least of the Restandardization System).

2. Use of some "special" solid-state products in a differential amplifier type circuit.

3. Use of solid-state components in a stable, memory type configuration.

For each of these types of approaches mentioned above, there arise a number of problems that are indigenous to the solid state approach; and these are:

1. Greater temperature sensitivity than "tube" circuits.

2. Nominally lower (for identical numbers of valves) operating parameter values (e.g. lower voltages, resistive loads, etc.)

Of course, the advantages possessed by the solid state line will more than offset the above disadvantages, and it is primarily for this reason (less weight and bulk, longer life, less power consumption, etc.) that we are attempting to preempt the tube version of the restandardization circuit.

With reference to development types 1 and 2 above our research into the problem thus far indicates that neither method has ever been successfully accomplished. This is primarily due to the fact that the VX-55 or CK5886 tubes (as are presently used in the restandardisation circuit) have input impedances of the order 10^{10} - 10^{14} ohm, whereas transistorized types have been limited thus far to 10^{8} ohm .

We believe, however, that we can develop input impedances in a solid-state type version that will approach 10^{9} ohms or more input impedances. This in turn would then require a capacitor of the order of 10 MFD (as compared to a value of 0.1 MFD on the existing tube version) for the memory input section of the Differential Amplifier.

We are also in contact with a number of semiconductor applications manufacturers of special types of solid state components. These

include Tung-Sol, Texas Instruments, Siliconix, Amelco, Crystallonics, Fairchild, and National Semiconductor. These manufacture special high input impedance semiconductor devices such as:

(a) Field-effect transistors

(b) Packaged (singlu chip) diff. Amplifiers

(c) Extremely high gain ($h_{FE} > 800$) transistors

(d) Compound Modules (integrated Darlingtoo Amplifiers)

(e) Special (custom-engineered) semiconductors (e.g. photocell type high Z circuits)

With regard to design approach 3 above we have proceeded with research into and the preliminary design of a member of circuits and these include:

(a) Unijunction transistor circuits C Bridge type memory circuits

(b) Hall effect memory devices D Comparator Circuits

A number of basic designs are presently either undue test or in the "breadboarding" stage. In addition, we will be meeting with a number of applications experts (from the semiconductor manufacturers) during the latter part of July and August.

AIR BLANK

None of the material suspected of contributing to air blank contained in the system has thus far been identified as a causatine agent. However, some experiments with related organic solvents have indicated that formation of color at the small spot could be formed by an extraction mechanism.

After heating the reagent solution for overnight periods above 125° in glassware, a very slight darkening was noticed. Upon addition of nonaqueous-miscible ketones to the solution, the solvent extracted the color into quite dark layers. We think this may be a clue as to how unreactive materials may act to form a dark spot under the head by extraction and concentration. Experiments with the paper tape have failed to show any increase in darkening over ordinary filter paper or paperless control solutions.

Typical experiments in this area were performed as follows:

Experiment #1 - Made up a standard reagent solution and heated at 115°F (The solution was divided into 3 parts of approximately 40 ml each into 50 ml glass beakers. Beaker 1 was the control. Beaker 2 contained approximately 1" long piece of E41 Alarm paper tape. Beaker 3 contained approximately 1" long x 1/2" wide piece of standard lab filter paper.) for 24 hours - (no color developed, approximately 40 mls in a 50 ml beaker).

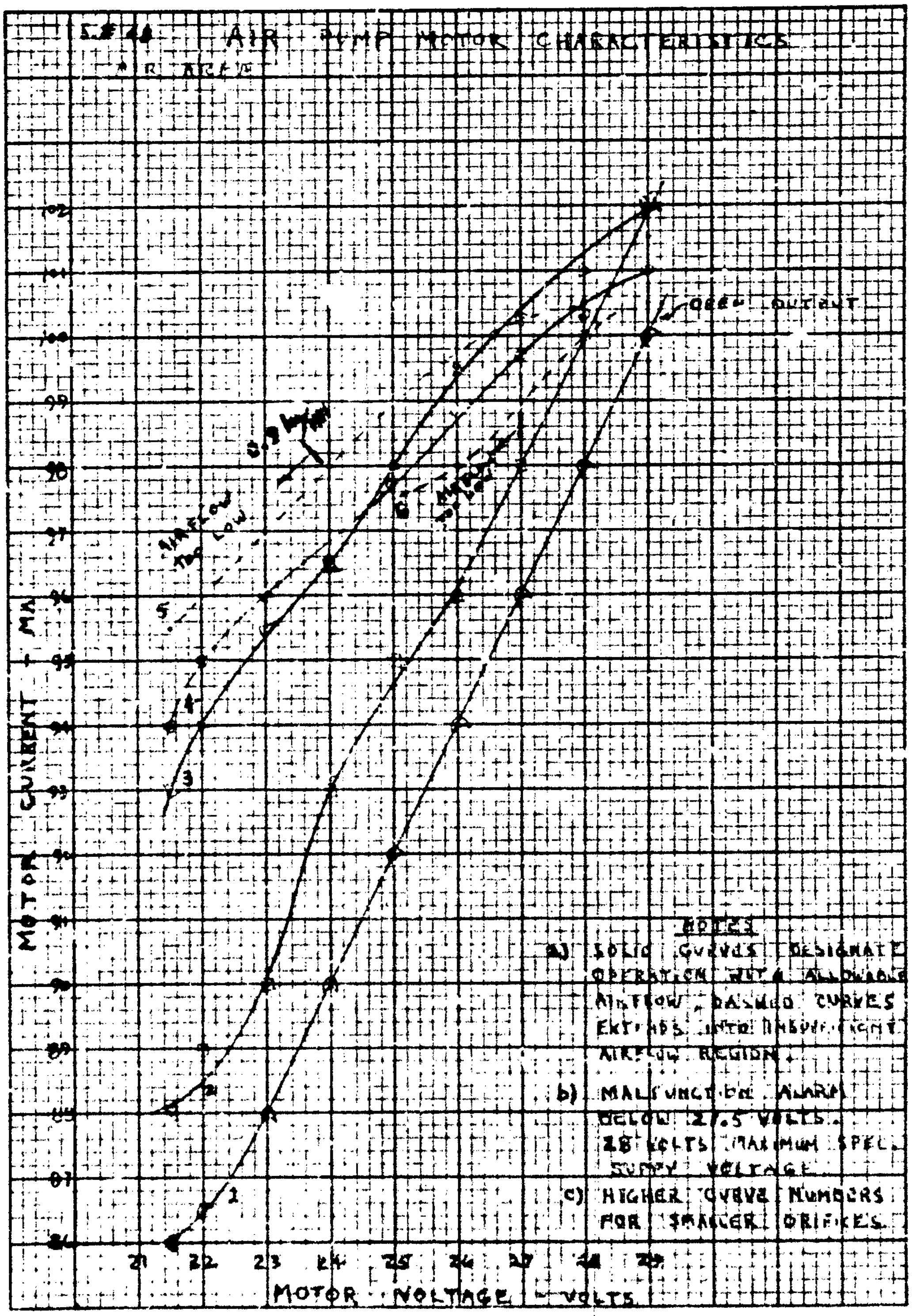
(a) to cooled solution add 1 drop (approximately 1/20 ml) of MEK peroxide - (60% in dibutyl phthalate) immediate color formation is observed at the drop-solution interface.

(b) to (a) was added 1 drop of DET (diethylene triamine) and the color of the drop and of the solution was increased to a brownish-yellow.

(c) to step (b) was added approximately 10 ml of MEK, and upon separation of the MEK and H_2O almost all the color was extracted to the upper level. This portion of solution was deep orange in color. Upon evaporation of the MEK dark red spots were left on the side walls of the beaker and the aqueous solution remaining was pinkish-yellow in color.

Experiment #2 - A solution was prepared and provided with E41 Alarm paper and standard lab filter paper as in Experiment #1, however, this time the temperature was approximately 135°F, and after a 36-hour period, a deep yellow color development was noted in all three beakers with no discernable intensity difference to the naked eye.

While no MEK Peroxide or DET was added to any portion of #2a, b, or c, approximately 10 ml of MEK was added with agitation to samples 2a, b, c, and deep red brown color extraction again resulted.



AIR PUMP MOTOR CHARACTERISTICS
MOTOR CURRENT - MA
MOTOR VOLTAGE - VOLTS
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1
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AIRFLOW TOO LOW
DEEP CUTOUT
NOTES
a) SOLID CURVES DESIGNATE OPERATION WITH ALLOWABLE AIRFLOW, DASHED CURVES EXTENDS INTO INSUFFICIENT AIRFLOW REGION.
b) MALFUNCTION ALARM BELOW 27.5 VOLTS. 28 VOLTS MAXIMUM SPEC. SUPPLY VOLTAGE
c) HIGHER CURVE NUMBERS FOR SMALLER ORIFICES.